IN'1'1CRNA'1'1ONAI, NDT TECHNICAL COl,1, ABORA'I'1ON USINGTHEINTERNET

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ABSTRACT

The power of Internet is increasingly being recognized as a communication tool that provides information in multimedia formats at speeds that cannot be matched by any other known method. in a short time since its inception, Internet became a household name and NDE communities around the world are rapidly recognizing its power. As the number of Internet tools and interactive archives are growing exponentially it is time for the international NDT community to coordinate its efforts. Areas that can be benefited in short terms are the formation of international NDT standards and process specifications, as wc]] as the establishment of Internet con fercnccs, journals and international expert pool. Another important area is the creation of an international NDT database which will be linked globally to the numerous NDT websites around the world. To assure the quality of the webpage input, an international panel of reviewers will monitor the content of the information that is being logged. This paper was coauthored by multi-national individuals who set an example of technical NDT collaboration over the Internet by electronically coauthoring this paper. The paper summarizes the technology status, highlights current NDT Internet activities and suggests action items for international collaboration.

INTRODUCTION

This paper reviews the capability of the Internet as a world-wide NDT communication tool for technical collaboration, dissemination of information and international standards. This paper was written by authors that never personally met (except for two) and despite thousand of miles distance between them the authors managed to work as a team to complete this paper in a very time efficient manner. This success is attributed to the power of the Internet and it represents a simple example of the "miracles" of this new technology that have revolutionized the way we communicate with each other. This technology had the most impact on information exchange and archival since the invention of the phone. As the number of users grows exponentially, the power of this tool is being widel y harvested in many forms including e-mai 1 and webpages [1].

This technology started in 1969 with the formation of DARPAnet and was the result of tbc U.S. Department of Defense (DoD) fear of losing computers ability to communicate during a nuclear war [2]. Hence, the Internet was designed as a redundant network and as an unorganized system where each computer is an equal partner with all other peers, i .e., no centralization and no hierarchy. An additional feature of the D ARPAnet, that made it very effective, was its protocol that enables exchange of data bet wccn computers with a different operating systcm. The transfer of the DARPAnet outside DoD started with DARPA desire to improve the communication among remotel y located researchers at universities and other organizations throughout the U.S. 'J'his led to

the development of the "Internet" protocol which superseded a]] other protocols available at that time.

Communication backbones, also know as servers network, was supported initially by the USA National Science Foundations (NSF) and was indispensable contributor to the development of Internet. 1 lowever, under the Acceptable Usc Policy (AUP), NSF support was limited to non-commercial applications. Internet started flourishing at the moment when communication backbones became available from commercial carriers, especially after the creation of the World Wide Web (WW W) and Mosaic. W W W was developed by Tim Berners-Lee at CERN, the European Center for Particle Physics, to facilitate easy exchange of documents among researchers located in various corners of the world. It adopted the 11 ypcr Text Markup Language (HTMI,), to be a subset of the Standard Generalized Markup Language (SGMI.), as an information vehicle independent of computer platforms and systems. It also defined the Hypcr Text Transfer Protocol (] 1'1''1'1') and the Universal Resource Locator (URI,), so that a user can access documents distributed all over the world through hyperlinks (i. e., highlighted items in the text represent URI, addresses and clicking with a mouse on the items activate the desired webpage). The user, however, had to read documents in line mode like telex, which is a rather cumbersome tool.

The most impact on making the Internet technology widely used was the release of the browser called Mosaic in 1993 by Mark Andersen at the National Center of Supercomputing Applications, Universit y of 1 llinois (as an undergraduate project). Mosaic and its commercial derivatives, notably Netscape, retrieve documents and render them to a user-flicnclly graphic form. Most operations can be done by just "point and click" of a mouse, which made the W W W accessible to everyone. The Internet enables the communication of every imaginable form of data, including files, data, text, programs, pictures, video and sound. As an outgrowth from the original idea of equal computer peers, the spirit of the Network is: People helping people for "free" (using uncensored and low cost communication), enabling the formation of a "global village". Thus, the Internet has leveled the playing field such that, as long as someone has good ideas, it makes no difference whether he/she is a high powered lawyer on Wall Street or a young teenager in a small town overseas. A schematic view of the Internet connectivity between the user and the addressee is shown in Figure 1.

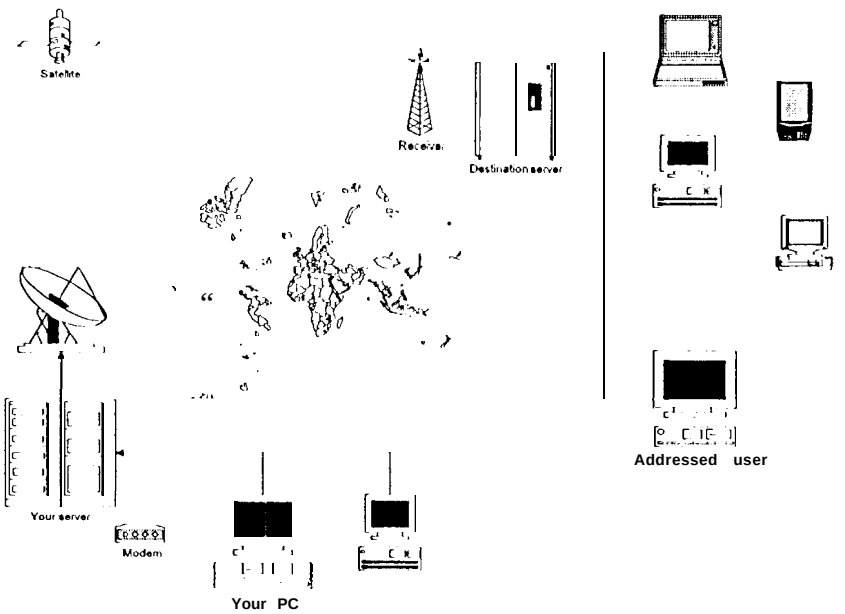

FIGURE 1: A schematic view of Internet communication between a user and an addressee.

The broader aspect of the Internet has been that its "free" nature allows rapid operation under difficult conditions, such as wars and civil conflicts without censorship. Further, the Internet totally c.hanged many companies information handling policies since everybody has an easy access to many sources. This forced companies to form a ncw management hierarchy to deal with the open system of Internet. W WW and Internet arc offering companies numerous capabilities in rca]-time: it allows to form and up-to-date electronic brochures describing the company, its experts, products and services. Some companies arc starting to take advantage of the online benefits, e.g. parcel deliver companies arc using interactive programs that show users where their packages arc during its journey. This gives a good service to customers while saving the providing companies in labor costs as WC]] as reducing the need for slow and frustrating process of answering by phone

Most business organizations, particularly in the USA, have now access to a high speed Internet communication connection and many public libraries/schools have terminals that arc available for public USC. At home, to connect to the Internet the user needs a computer with a modem, a phone linc and a network service provider. The exponential growth of the Internet is providing easy access to an international network from every comer of the world. Once on the Internet, there arc neither long distance charges nor international charges and the equipment, that is compatible with the Internet, is cost-effective because of the large number of users. Unlike conventional print media, there is no cost difference between black&white and color images and animation, movies, three-dimensional images and even virtual reality can be handled easily.

CURRENT CAPABILITIES OF THE INTERNET

The Internet provides numerous powerful communication and multi-media tools. To appreciate the related capabilities that can be used for NDT technical collaboration, it is necessary to be familiar with the available tools. The following reviews some of the leading Internet tools that arc available today.

E - m a i l

c-mail is quickly replacing many other communication tools, e.g. phone, fax and mail. This is increasingly becoming the preferred method of communication among, technical individuals. Even though the "conversation" usually takes place in time-frame of minutes to hours, a person can check. the message when convenient, the level of details is as desired, and the fact that the information can be used for further processing (e.g., write a paper, report, presentation or proposal) makes c-mail a very attractive tool.

Browsers to Webpages

Browsers arc user-friend] y human to machine interfaces to the W WW. '1'here is a large number of' browsers and the leading ones are: Mosaic, Navigator, and Explorer. Most operations on the browser can be done by just a mouse "point and click" and it accesses webpages that arc provided to the user on remote computers and servers. Webpages arc formed by companies, individuals and anyone who is seeking to offer a multimedia information. Webpages arc now incorporating many Internet features, including FTP, c-mail, newsgroups, Chat, and message boards. Also, webpages arc providing onl inc conferences, training, workshops, "Ask the expert" forums and in education -- virtual classrooms are being used. The response time of these tools varies from seconds and

minutes to hours. Collaborative tools such as bulletin boards and newsgroups can be easily incorporated in the WWW services. Network security is an important issue and numerous means of securing communication as well as access control are now in use. 1 lence, a provider can offer simultaneously free services to the general public and exclusive services to its members. Interactive communication between a web server and a browser is provided by "mail to" and "form" tags of the language 1 ITML. While this language has, at present, a limited capability it is expanding rapidly with the assistance of Java software options.

Newsgroups

Technical communities are increasingly teaming to communicate various announcements, inquiries, etc. '1'here are over 15,000 newsgroups, with their own distinct topic of discussion ranging from care of houseplants to techniques in mass spectroscopy. Usually, a specific question is posted and then answered by newsgroup readers within several hours.

inter Relay Chat (IRC)

in a time-frame of seconds, this form of communication is used as a timely substitute to annual meetings. IRC is the Internet equivalent of the telephone party line, except that the communication is in text rather than voice. Dozens of people can communicate in a real-time forum once a time and channel are arranged. On any day, there may be over 10,000 IRC active channels, each with its own topic of discussion. To get onto IRC, the user needs in addition to an Internet connection also a special software (freeware, see: http://www.thezone.pair.com/mirc/). The IRC software requires two parameters: an IRC server and an IRC channel. 'J'here are more that hundred servers from which to choose. The criteria to choose a server include, its geographic proximity to the user and its case of access, i.e., not being overloaded with users. There are networks of servers like Efnet, Undernet, Dalnet, and Uppernet, but unfortunately, most servers are not connected to each other. once an IRC server is selected, the channel to which to join needs to be identified and it is an IRC command allowing to view: the currently available channels; who are the individuals on the channel; and what is the topic of the discussion. A user can participate in several different channels at the same time. A channel can be defined in advanced and it requires an arrangement with the planned participants to assure the presence of others on the channel during active chat communication.

Electronic Conferences

Voice conversation (real time) can now be made internationally at the price of a local call. With the recent introduction of standard freely accessible software from several computer companies, this technology is expected to become a dominated communicat ion method that may change the phone as we know it. Mu]ti-user interactive communication is increasingly being employed to form teleconferences employing mostly audio and text and increasingly expanding into video format. Video broadcasting are still at early stage of development. Improvement in quality and expansion of communication bandwidth are necessary before receiving wide acceptance by the general public.

Database searches and document retrieval search engines/agcnh

Powerful search engines and intelligent agents are now available for searching relevant information over the Internet. Search is still far from being perfect and the results may contain certain amount of noise, i.e., irrelevant information. For an efficient search, it is helpful if the word "ND']'" is included somewhere in a text of the NDT webpage provider. '1'0 allow search of specific items,

most search engines are now allowing the use of Boolean combinations (and/or). The search is an iterative process of browsing and information retrieval, where the search engines are attempting to provide ranking of search results and the best-match is shown first. Effective results are requiring a systematic, exhaustive and highly specialized search. Examples of the available search engines include: Yahoo, Alta Vista (full text), Lycos, Infoseek, Excite, as well as simultaneous search over multiple databases via Meta Search Engines (e. g., Savvy Search). Most search services are offering a simple input window, without any additional help information, whereas some advanced tools are available with hidden links [3].

NDT AND THE INTERNET

In the last two years, many NDT organizations formed webpages to provide information about their product, capability, services and hyperlinks to many other related websites. ASNT recently formed its own webpage [http://www.asnt.org]. Some of the NDT tools and webpages that are available internationally are reviewed herein:

NDT WEBPAGES IN THE USA

The NDT **community in** the USA has recognized the power of Internet and the World Wide Web. Having a webpage is now like having a business card, it provides identity description of the webpage owners. Numerous companies, organizations and individuals have formed webpages which are hyperlinked to other NDT websites. At the beginning of this year, ASNT joined the community of organizations having a webpage (see Figure 2). A user can review the various NDT services and products, access con ference information, send e-mail messages to any of the society representatives and access numerous NDT websites of other organizations [http: //2 06.21.77.126/links/ nonprofitlinks/non.htm]. Also, the various committees of ASNT are now documenting their Minutes on webpages that are hyperlinked to the ASNT webpage. As an example one can view the Ultrasonic Personnel and Qualifications as we]] as the Ultrasonics Commit ittess' webpage [http: //nasa-nde.jpl.nasa.gov/jpl-nde/asnt-ut/homepage.htm].

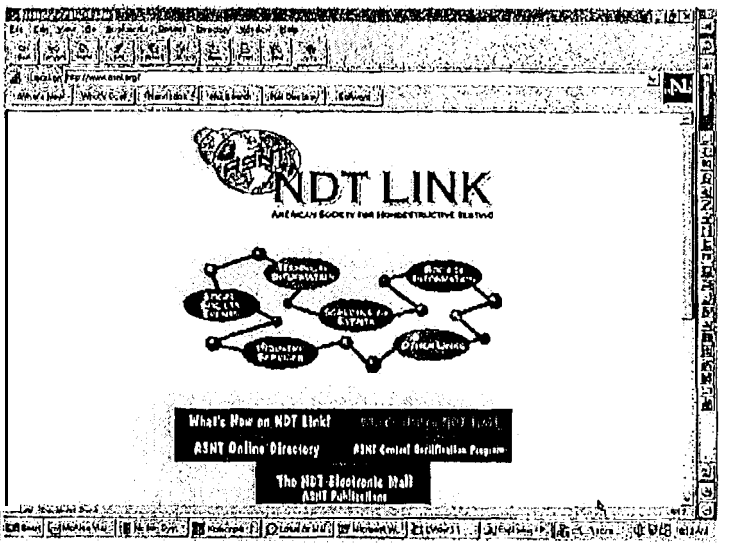

Figure 2: A print-screen of the ASNT webpage.

Other organizations that started using webpages 10 inform of con ference announcements and agenda include lowa State University. This year, for the first time the Review of Progress in Quantitative NDE was announced on a webpage ahead of the con ference and details such as registration and others were available [http: //www.cndc.iastatc. edu/qndc/qndc_ reg.html]. Various organizations arc providing databases that arc very useful to the NDT community. This include acoustic properties of various materials [http://stud.uni-sb.dc/~mala/acoustic.html#acoustic and http://www.ultrasonic.com/Tables/index.html] as well as the properties of piezoelectric materials [http://www.ultrasonic.com/Tables/long.htm]. Some webpages cover specific methods such as acoustic emission [http://www.tricity .wsu.cdu/~mfriesel/index.html]. Increasing, one can find individual papers posted as webpages as the example onc can view a paper about Damage identification and 1 Iealth Monitoring on the website of the I .os Alamos National Laboratory [http://wxvax7 .esa.lanl.gov/damid/damidhomc.html]. Other leading organizations that arc providing detailed webpages include, NTIAC [http: //www.dtic.dla .mil/iac/ntiac/], NASA NDE Working Group [http://nasa-ndc.jpl.nasa.gov/jpl-ndc/homepage.htm], and IOWA [http: //www.cndc.iastatc. edu/cndc.html]. The capability and the latest technology available from various organizations arc also documented in webpages as for example onc can review the JPL website http://nasa-ndc.jpl.nasa. gov/jpl-ndc/ndc-aa-l/ndc-aa-l.htm which has hyperlinks to various activities of the NDE & Advanced Actuators (AA) Lab.

NDT WORLD WIDE AND NDT IN THE PACIFIC BASIN

Through an effort of NDT individuals from numerous countries, the NDT World Wide was formed as a not-for-profit and voluntary hypermedia devoted to improve the communication among international NDT communities. Beside news and calendar events, NDT World Wide is hyperlinked to numerous NDT societies and research institutes (see Figure 3). NDT World Wide is intended to be a guide post [http: //www.ricoh.co.j p/nct-nlcssena/NDl' W W/l NTRO/NDTWW-USJ.html], rather than a warehouse of NDT information, because of the organizers belief that information is best maintained and updated at the source locations. It is also recognized that the accessibility to the Internet varies from country to country. Therefore, NDT World Wide is assisting various NDT societies by preparing their webpages and providing them with a server to host their webpages until these societies form their own server. Among the various items that arc posted on the NDT World Wide website arc the final announcement of the 14th WCNDT, which will be held in India in December 1996 [http: //www.ricoh.co.jp/nct-messena/NDTWW/CALENDAR/WCNDT3/ WCNDT3.html]. Other international organizations arc also active in documenting Conference information. As a example, within days after its completion, the German/Austria/Swiss Annual NDT Con ference was reported on the U']'online Journal, with abstracts, interviews, and even a sound clip was provided [http: //www.ultrasonic. dc/articlc/rcport/cnfl_ 96/cnfl_rc.htm]. Further, the 1 st US/Japan Symposium on Progress in NDT was reported as a webpage as soon as the Symposium was over. It is interesting to note that many color pictures taken at the Symposium are included in the webpage [http://www.ricoh.co.jp/net-messena/NDTWW/US-J96/US-Jphoto.html]. There are also reports of the 8th Asian Pacific NDT conference [http: //www.ricoh.co.jp/net-essena/NDTWW/ INTERN/APCNDT/APCNDT.html] and the TC135 Meetings in Berlin [http: //www.ricoh.co.j p/net-messena/ NDTW W/INTERN/I SO 135 .html]. Webpages are now providing conference announcements, online forums, electronic conferences, workshops and electronic journals [http: //www.ultrasonic.dc/wshop/wshop_tr/transd_an.htm http: //www.ultrasonic. dc/ and http://www.ultrasonic.dc/demo.htm].

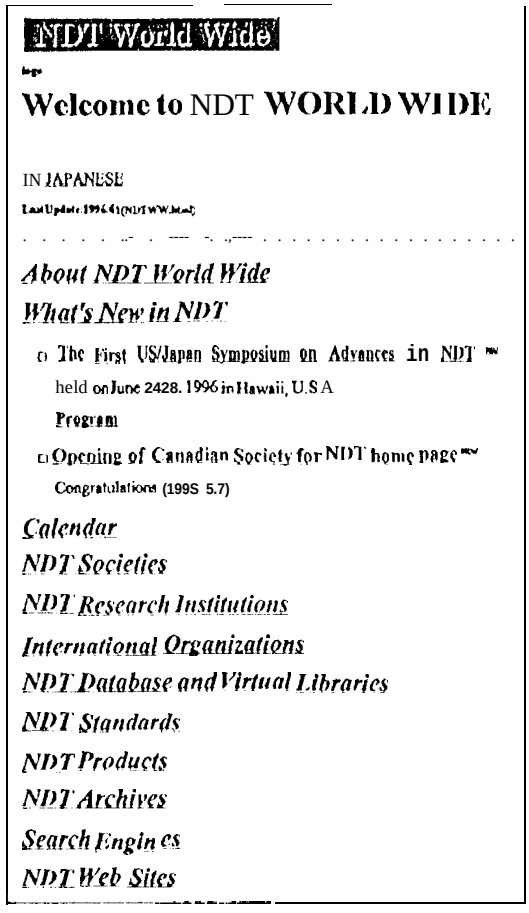

Figure 3: NDT World Wide webpage.

international standardization is another promising area for the application of the Internet. The traditional process of international standardization based on mailed documents cannot cope any more with the rapid progress of technology and the globalization of the world market. The Central Secretariat of 1S0 (International Organization for Standardization) has now ISO/TC135 (NDT) and ICNDT webpages onc set for the general public and another with exclusive access for the members (using a password). The speed of international standards development will be greatly improved by the positive use of the Internet.

NASA NDE WORKING GROUP (NNWG) WEBPAGE

in 1993, leading NDE representatives of all the NASA Centers agreed to form the NASA NDE Working Group (NNWG) to facilitate direct communication, collaboration and technical exchange across NASA and outreach to the technical societies, industry and the international community. To support the need for effective forum of communicant ion, NN WG started Workshops that arc held annually at different NASA Centers, hold periodic Teleconferences, issue the NNWG Newsletter (Y. llar-Cohen, one of this paper coauthors, serves as the Editor) and maintain an NNWG webpage that is connected to the NASA Webpage [http://nasa-ndc.jpl.nasa.gov/jpl-ndc/homepage.htm]. The NNWG includes hyperlinks to the various issues of the Newsletter as well as to other NDT websites. As of October 1996, the Newsletter will involve from its current hardcopy version to an electronic form. The use of Internet among the NASA NDE community has grown from several users in 1994 to a full access availability to all the members of NN WG. The usc of hardcopy mail and faxes has dropped significantly and most communication arc done now in an electronic form, including announcements, submission of proposals, elections, etc..

NDT NEWSGROUP

Newsgroups arc like electronic bulletin boards: a place to ask questions, to answer questions, or make announcements. The NDT Newsgroup (sci .tcchniqucs.testi ng.nondestructive) was created in July 1995, after it was proposed by M. Jones in 1994 and being campaigned and being voted (over 180 people from 16 countries voted in its favor). The Newsgroup has a mailing list, which is maintained electronically by the server and it allows subscribing individuals to participate in the Newgroup activity without any special access software. l'here is no cost associated with the

subscription and an average of 2 to 3 messages per day arc posted to this Newsgroup. The charter of the NDT Newsgroup dots not allow advertisement and amazingly, with no moderator, there is a remarkabl y small number of advertisement instances. Announcements of opportunities, technical inquiries, availability of capabilities, call for papers, request for proposals, employment announcement, etc. arc commonly posted on this electronic message board. For more information regarding the NDT Newsgroup charter, or how to access the archives of all past posts to the NDT Newsgroup, onc can visit the webpage: http: //www.ndc.swri.edu:8080/ To subscribe to the NDT Newsgroup via c-mail, onc needs to send a message to the address: **ndc-request@swrin dc.ndc.swri. edu** with a command "subscribe" in the body of' the email message. The subscription is done automatically and this method can also bc used to remove the user name from the distribution by sending a message ' `unsubscribc". To send a message to all members of the mailing list the c-mail message needs to bc addressed to: **ndc@swrindc.n dc.swri.edu** (there is no need to test the address - it works).

NDT INTER R EL AY CHAT (IRC) CHANNEL

M. Jones (one of this paper co-authors) has an established weekl y 1 RC Session to discuss NDT topics. The channel is called #NDT and it is using the Dalnet system as the server (ire.dal.net). The weekly topic is announced on the NDT Newsgroup (sci. techniques. testing. nonclcstructivc) and it is held on Wednesdays at 12:00 noon (eastern U.S. time). The transcripts of previous #NDT Sessions is available at http://www.ndc.swri.edu:8080/discu ssion.html. in case that an individual is interested in a topic but cannot attend an upcoming Session, a question or inquiry can bc sent to mpjones@ewi.org ahead of the meeting and the request is announced during the Session.

MATERIAL .S TESTING INTERNET RESOURCES (MTIR)

MTIR is a nonprofit corporation, that was created by M. Jones to promote the usc of the Internet among the materials testing industry. MTIR consists of ten directors from five countries. This corporation was formed duc to the belief that Internet is a valuable tool for engineers and scientists but no individual can keep up with the rapid improvement and growth of this technology. MTI R as a group combined its resources and knowledge to assist individuals and organizations to create material testing databases and other resources on the Internet. More information is available on the MTIR website:http://www.geocities.com/SiliconValley/3300/.

NDE 1 NTERNET IN EUROPE

Europe is rapidly following the lead of the NDE community in the USA. Generally, the Internet users arc still lagging behind as the UTonline Journal user statistics is showing. The Journal examined the use of its server in the month of July 1996 and the results(see Figure 4), based on 25,000 visits of the server showed that European used the server 66°/0 less that the USA users. Over the European users, the German showed the largest number and this lead maybe explained by the speed of the Internet response (bandwidth) to tbc local users in Germany. UTonlinc was accessed strongly by the 15 Fraunhofer Institutes, who read 140/0 of the Online files.

Recently, the German NDT Society started a webpage service and has provided useful information that is translated to English. German NDE manufacturers arc still lagging to provide webpages because of their misconception that "our customers arc not using Internet yet" or "I don't believe we can sell ultrasonic instruments via the]nternet". As a contradiction of these statements, onc can

quote readers of the Url'online Journal who are sending feedback stating: "I just read this article and 1 am wondering who can deliver such a system? (Plant Manager)".

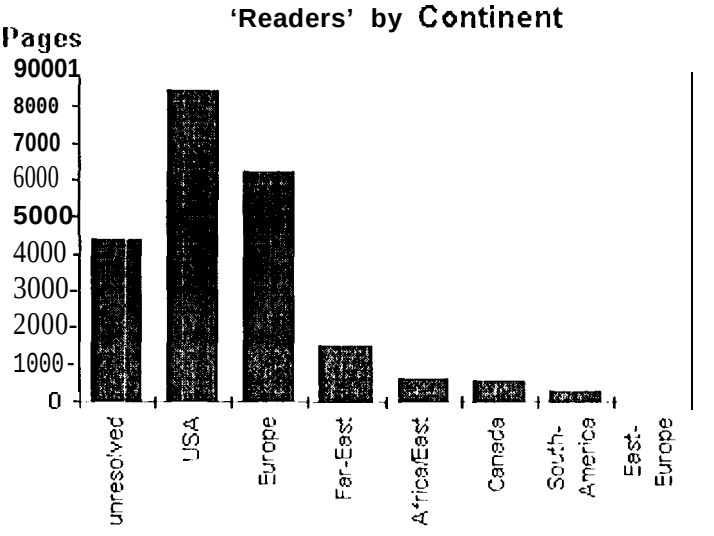

FIGURE 4: Statistics of international Internet inquiries made to the U'1'online Journal during the month of July, 1996.

in contrast to Germany, the U.K. has already made significant progress in making useful manufacturers and Institutes NDT webpages. The U.K. access of the U'1'online server was ranked number two for the European users and only limited reader feedback was recorded. The British Institute for NJ DT has recently formed a webpage and its address is http: //www.powertech.co.uk/ndc. Relatively to their size, Switzerland has a strong Internet user base, and as an example ETH Zurich is providing great NDT information on its webpage . Further, even though they were ranked number 3 on the statistical ranking of visiting the U"J'online, a search of French NDT webpages was unsuccessful.

The European Community offers a large information database, so-called CORDIS through its Community Research and Development information Service and it describes all the Research and Technological Developments (RTD) activity in Europe. At present, CORDIS offers 146,000 documents in 9 databases and they arc offered for free access, via a the cumbersome Telnet tool. EC has already begun to provide search forms on their webpage and recently announced that soon all its databases will bc accessible via WWW.

In Sept. 96, Url'online Journal (see Figure 5) will have its first Ultrasonic Online Workshop [http: //www.ultrasonic.dc] and the subject will bc Transducers. This is a new and unique Internet NDT experience and the theme of the workshop is an "Ask the Experts Forum". The forum (web page) feat ure papers of the pane] of experts, as wc]] as their photos. A Workshop-Library provides further information about transducers. The available resources, include: articles, abstracts, alphabetic ultrasonic information, and hyperlinks to other related websites. Also, an interactive Transducer Quiz (Q&A) is provided and was produced using a Java script. The discussion procedure is based on an interactive form, where the readers fill in questions or contributions and the information is posted automatically at the Workshop "virtual site". The form supports attachments, e.g., documents, images, and URL addresses. Panel members take turn answering questions, where each is assigned onc day of the week for the whole month of September.

Questions are answered, within 1-2 days and the workshop is opened for feedback. The attendance of this Internet workshop is free! and it a virtual environment with a UT online Exhibition and Transducers Hall.

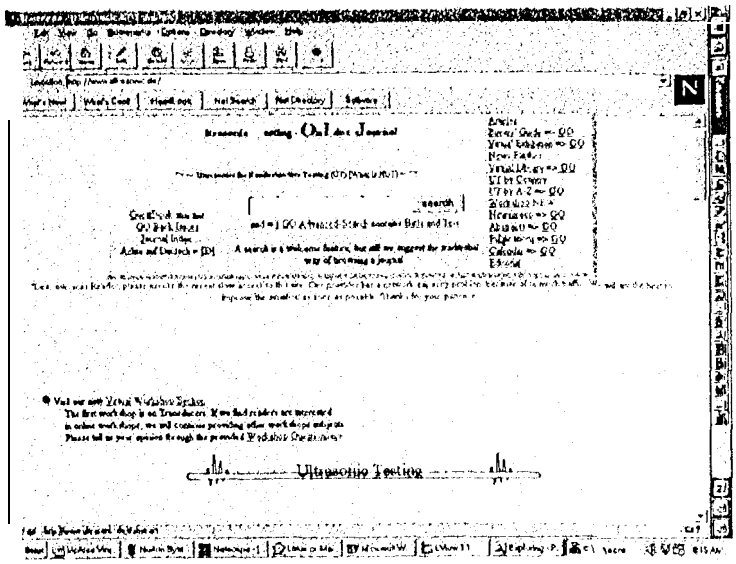

Figure 5: U"]'online Journal webpage.

NEW ZEALAND NDT ASSOCIATION

Another active NDT organization on the Internet is the New Zealand NDT Association (NDTA) [http://www.irl.cri.nz/~spedding/ndta/ndta05.htm]. NDTA has one of the most unique and capable webpage layout and it is configured as a stack of folders (SCC Figure 6). Clicking on the tab of the folder items accesses various information resources, including employment opportunities, NDT information, etc.. While the NDTA webpage was formed only recently, the New Zealand NDT Association has a longer history -- it was formed in 1977.

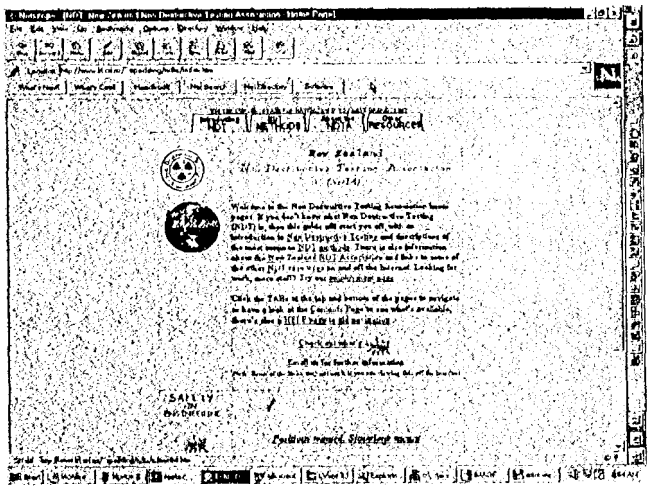

Figure 6: The **New** Zealand NDT Association Webpage.

THE CANADIAN SOCIETY FOR NDT

A detailed information describing the history of the Canadian Society for NDT is available on their webpage http://www.vaxxinc.com/jng/chtml/csndt.html. The outline of this webpage is showing a list of hotlink options on the left and the details of the selected options are shown in a specially window on the right. The various services, products, society charter, scholarship opportunities, and events are all hyperlinked to this Internet address.

PROPOSED FUTURE ACTION

Online communication is expected to make an impact on our life in a significant way similar to the 'Book printing' and 'Electricity'. The NDT community needs to consolidate its effort in order to effectively take advantage that this new technology is offering. Numerous capabilities are now possible which involve distant individuals and facilities and the action can be accomplished in a very short time. Global markets are expanding the NDT activities, and it is becoming increasingly vital to the assurance of products quality, safety of plants and the preservation of the environment. A plant in a remote country can now be designed, constructed and inspected by service providers in different countries. The Internet is an indispensable component of the infrastructure for such collaborative development processes. Further, the internet is allowing online publishing and it is expected to be the dominate way of publishing - papers will be sent electronically to journal websites and will be posted on the webpage once it is reviewed by an international panel of experts (who might be later substituted by an expert system).

The use of the Internet capabilities, such as webpages, electronic databases, NDT teleconferences (audio/video), IRC and e-mail can enable the world NDE community to make a better use of its resources and respond faster to the rapidly changing needs. ASNT can take the lead in this global Internet networking that will link all the NDT experts throughout the world. Major concerns that need to be addressed include copyright, security and universal access These issues are already being addressed by the Internet providers and significantly more secured tools are now available to protect the provided Internet information.

ACKNOWLEDGEMENT

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